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Effect of Mirror Therapy on Fine Manual Control in Children with Erb's Palsy

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ABSTRACT

Background: For children with Erb's palsy, difficulties with fine motor control often present as a serious problem that affects their activity of daily lif ADL activities.

Objectives: To examine the impact of mirror therapy on fine manual control in children with Erb's palsy.

Subjects and Methods: Thirty children with Erb's palsy with their age ranged from 5 to 9 years participated in this study. They were at level 1 on Manual Ability Classification System (MACS) and they were able to follow instruction given to them, they were excluded if they had residual deformity and operation in the hand. They were randomized into two groups: control group (A) as well as study group (B). Both groups were given a designated physiotherapy program as well as control group were given program to improve the fine manual control, while study group were given the similar program but in front of mirror (mirror therapy). Fine manual control was evaluated before and after the treatment utilizing Bruininks Osertesky Test Bot-2, and the program was performed for an hour, 3 sessions per week for 3 consecutive months for all groups.

Results: Both groups showed significant improvement in fine manual control post treatment. Significant improvement after treatment in the fine manual control was found favoring study group ($p<0.05$).

Conclusion: Mirror therapy can be utilized in the treatment program of children with Erb's palsy to improve the fine manual control.

Key words: Erb's palsy, Fine manual control, Mirror therapy.

INTRODUCTION

Erb's palsy is a paralytic disorder of the upper extremity caused by a traction damage to the brachial plexus's upper trunk [(1)].

Children with Erb's palsy typically exhibit specific physical manifestations. These include a limp arm positioned next to the body, medial rotation of the shoulder, complete extension of the elbow, pronation of the forearm, as well as flexion of the fingers and wrist. The adduction of the shoulder is a result of the paralysis of the deltoid as well as supraspinatus muscles. Additionally, the active pectoral as well as subscapularis muscles, along with the inactive infraspinatus as well as teres minor muscles, contribute to the internal rotation of the shoulder. Furthermore, the extension of the elbow is primarily induced by gravity along with the paralysis of the elbow flexors, including the biceps, brachialis, as well as brachioradialis muscles [(2)].

The primary functions of the hand include grasping, supporting, striking actions, free movements along with dexterity, expressing oneself and interacting with others, as well as sensory reception and orientation [(3)]. Because children with Erb's palsy cannot laterally rotate their shoulders or flex their biceps, two essential movements for hand functions such as feeding as well as self-care, the patient's hand is in a position that is of little importance to the patient [(4)].

Erb's palsy results in permanent structural and function sequelae in hand that limit the motion of articular range and reduce independence in daily activities, as well as the children participation in their natural environment [(5)].

Mirror therapy is an interesting treatment modality for clinical application due to its ease of implementation, relatively low cost, reduced patient apprehension, potential for home-based intervention with appropriate guidance and instructional materials, and frequently higher effectiveness compared to alternative treatment approaches [(6)]. The objective of mirror therapy is to enhance the functionality of the affected upper extremity and enhance the overall quality of life in various conditions. Additionally, mirror therapy can be conducted at home to decrease parental stress and enhance family-child communication [(7)].

There is a lack in the research area concerning the impact of mirror therapy on fine manual control in children with Erb's palsy. Therefore, the aim of this study is to examine the impact of mirror therapy on fine manual control (fine motor precision and fine motor integration) in children with Erb's palsy.

SUBJECTS AND METHODS

The current study was conducted at Kom Ombo Central Hospital in pediatric physical therapy clinic from April 2023 to July 2023.

Ethical considerations:

The study received approval from the ethical committee of the Faculty of Physical Therapy at Cairo University (REC/012/003790). At the beginning of the study parents of all participants signed informed consent regarding participation of their children in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

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Thirty children of both sexes with Erb's palsy took-part in this study. They were aged from 5 to 9 years, they were at level I on Manual Ability Classification System (MACS) [8], and they were able to understand orders given to them. The children were excluded if they had deformity or stiffness of wrist or finger joints, neuromuscular and musculoskeletal abnormalities other than Erb's palsy, cognitive or visual disorder that limited the child's ability to do the activities and surgeries of the affected upper limb.

Methods

Methods for evaluation of motor proficiency Bruininks osertesky test (BOT-2) was used to evaluate fine manual control (fine motor precision as well as integration). It uses game-like motor activities, which maintain the child's attention and don't require a lot of verbal explanation. It is valid as well as reliable. The BOT-2 includes tasks assessing precision, integration, as well as manual dexterity by means of drawing, writing, as well as functional activities including threading a block [9].

Gharaei *et al.* [10] found that BOT-2 had adequate validity and reliability, in addition to high sensitivity and characteristics in preschoolers. In addition to being used as an educational as well as intelligence test, the BOT-2 could also be used to assess hand function of the child (fine motor precision, fine manual control), manual dexterity and bilateral hand use.

A-Evaluation of fine motor precision

Included assessment of 7 items as following [9]:

- Filling in shapes (circle and star): the child was requested to hold the pencil in affected hand and color each shape, staying inside the lines and filling in the shape as completely as possible.
- Drowing lines through paths (crooked and curved): the child was asked to draw a line through each path from the car to the house.
- Cconnecting dots: the child was asked to draw straight lines to connect the dots in proper sequence without lifting the pencil off the page.
- Folding paper: at beginning, folding the corner of the paper labeled by examiner on its line was demonstrated, then the child folded each of the three remaining corners along each line and then folded the paper in half along the middle line.
- Cutting out circle**:** the child hold the scissors and cut out the circle.

B-Evaluation of fine motor integration :

The child was asked to hold the pencil and copied each shape as exactly as possible: (using a pencil to copy shapes such as a circle, square, overlapped circles, wavy line, triangle, diamond, star, and overlapped pencils.

During the testing session, the child's performance on each item was recorded, after the testing session each item raw score was converted to point score using the conversion table then point score was converted to scale score, at the end scale score was converted to standard score.

Methods of treatment

Children in both groups were given a designated physiotherapy program to enhance upper extremity function. This program consisted of passive mobilizations to avoid shortening, strengthening exercises, as well as active mobilizations (all carried out within the physiological limits of every joint to prevent over stretching [5]**.** Treatment consisted of a half-hour session, three sessions weekly, for three consecutive months, and was customized to each child's motor skills. In addition to:

- Children in control group were given specific physiotherapy program focused on improving the fine manual control (fine motor precision as well as fine motor integration) included the following exercise:

-Rotate 2 ball in hand clockwise and counterclockwise [11]**:** the patient was asked to rotate the two ball in clockwise and counterclockwise .

-Writing , painting, using scissors and folding paper [12]: the child was asked to writing and painting with crossing to the center then the child was asked to use scissors and fold the paper, this treatment program was carried-out for half an hour, 3 sessions a week for three consecutive months based on child motor ability.

-Children in study group were given the similar designated physiotherapy program as control group for half an hour, 3 sessions a week for three consecutive months; in addition, they received mirror therapy, the child was requested to sit on chair and in front of mirror (20×25 cm in diameter) and the affected hand behind the mirror while, the non-affected hand in front of it. The child was asked to rotate two balls in clockwise and counterclockwise in front of mirror, the child was requested to writing and painting with crossing to the center in front of mirror then the child was asked to use scissor and fold the paper in front of mirror.

Statistical analysis

Unpaired t-test was conducted for comparison of age, weight, height between groups. Chi squared test was conducted for comparison of sex and affected distribution between groups. Normal distribution of data was checked using the Shapiro-Wilk test. Levene's test for homogeneity of variances was conducted to test the homogeneity between groups. Unpaired t test was conducted for comparison of fine manual control, manual coordination and fine motor composite between groups and paired t-test was conducted for comparison between pre and post treatment in each group. The level of significance was set at $p < 0.05$. All statistical analysis was conducted through the statistical package for social sciences (SPSS) version 25 for windows (IBM SPSS, Chicago, IL, USA).

RESULT

- Subject characteristics:

Patients' characteristics for both the control as well as study groups are shown in table 1. Age, weight, height, genders, as well as the distribution of the affected side did not differ significantly across the groups.

Table 1. Basic characteristics of participants

	Control group	Study group	t-value	p-value
	mean ± SD	mean ± SD		
Age (years)	7.13 ± 1.13	7 ± 1.55	0.26	0.79
Weight (kg)	25.86 ± 2.77	26 ± 3.48	-0.11	0.90

Effect of treatment on fine manual control:

- Within group comparison:

There was a significant improvement in fine manual control, after treatment in comparison with that before treatment in control and study groups ($p < 0.01$). The percentage of change in fine manual control in control group was 17.18, 25.36 and 24.08% respectively and that in study group was 47.44, 78.31 and 75.32% respectively (Table 2).

- Between groups comparison:

Pre-treatment comparisons showed no statistically significant differences among the groups.

After treatment, the study group showed significant improvement in fine manual control in comparison with the control group (Table 2).

Table 2. Mean fine manual control, pre as well as post treatment of control and study groups.

	Control group	Study group			
	Mean ± SD	Mean ± SD	MD	t-value	p value
Fine manual control					
Pre-treatment	32.60 ± 5.77	34 ± 4.89	-1.4	-0.71	0.48
Post treatment	38.20 ± 5.53	50.13± 7.64	-11.93	-4.89	0.001
MD	-5.6	-16.13			
% of change	17.18	47.44			
t- value	-7.75	-11.07			
	p = 0.001	***p = 0.001***			

SD, standard deviation; MD, mean difference.

DISCUSSION

The purpose of this study was to examine the impact of mirror therapy on fine manual control in children with Erb's palsy. 30 children with Erb's palsy with their age ranged from 5 to 9 years, were randomized into 2 groups: control group (A) as well as study group (B). Both groups were given a designated physiotherapy program as well as control group were given program to improve the fine manual control, while study group were given the similar program but in front of mirror (mirror therapy). Each group participated in the treatment for three consecutive months, for a total of one hour, 3 sessions a week, fine manual control was evaluated at baseline and after treatment by utilizing Bot-2. Both groups showed significant improvement fine manual control post treatment, significant improvement after treatment in the fine manual control was found favoring study group ($p<0.05$).

Selection of fine manual control affection as a problem due to Erb's palsy to be controlled in this study by mirroring therapy, as this problem affect the child performance in daily life. This comes in agreement with **Strombeck** [13] who said that hand function was affected in Erb's palsy as a result of the impact of restricted children movement in hand positioning as well as decreased grip strength and affection of performance in daily life activity as bimanual activity requires the use of the injured hand.

The post treatment improvement in fine manual control in control group (A) may be due to design physical therapy exercise program included writing, drawing and using scissor. This is supported by **Toth R** [14] who said that children with injury in the hand who perform writing, drawing and playing repetitively; their manual capabilities improved and later on these manual capabilities link to several cognitive skills, which improve the function of the upper limb. Also **Carr and Shepherd** [15] said that skill development of the affected hand, through carefully designed activities focused on gripping, manipulating objects, and performing fine motor tasks, the consistent and targeted engagement in these exercises fostered neuroplasticity, promoting the rewiring of neural pathways and facilitating motor learning in the affected limb, the repetitive practice of specific movements contributed to the refinement of motor control and hand coordination. As a result, participants in the control group exhibited enhanced fine manual control after the intervention, owing to the positive impact of the tailored physiotherapy program on neural adaptation and skill acquisition.

The after-treatment improvements of fine manual control in group (B) may be from the mirror illusion of normal motion of the functional limb, which replaces the reduced proprioceptive input and aids the visual pathways to the brain to override a lake of sensory input. That agrees with **Bondoc *et al.*** [16] who studied effect of mirror therapy combined with tasks of upper limb as writing and drawing and showed that when mirror therapy is utilized as adjust technique to tasks of upper limb it provides clinically meaningful improvement in

motor functions of the affected limb. This visual illusion may increase an activity at primary motor cortex as well as the descending neural signals from the brain towards the muscles of the affected extremity, leading to an improvement in the affected extremity's functionality, as reported by **Gygax *et al.*** [17] who also noted that viewing the functional upper extremity in a mirror appeared to have a rapid impact on motor unit firing. Also improvement in group B may result from mirror therapy as a result of overcoming the learning unuse phenomenon by increasing the special attention towards the affected limb and made positive change in neural plasticity; that came in agreement with **Buccino *et al.*** [18] who explained that child with paralytic limb may end to state of learned nonuse by continuous avoiding the usage of paretic limb, mirror therapy increase the attention towards the affected limb due to activation of the motor network of the affected upper extremity as a result of neural plasticity and illusion of normal movement.

Limitation and recommendation:

The current study was limited to children with Erb's palsy with age 5 to 9 years, they were on level 1 on Manual Ability Classification System (MACS). So further studies are required on another age group and on another level on MACS.

CONCLUSION

From the findings of this study, it can be concluded that mirror therapy can be considered as a useful important therapeutic modality to improve the fine manual control (fine motor precision- fine motor integration) so the hand function improves in the children with Erb's palsy.

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